

METHYL BROMIDE USE, ENVIRONMENTAL IMPACT AND WORKER SAFETY

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Methyl bromide (MB) is the active ingredient in a number of restricted use agricultural pesticides. Several formulations are currently registered with the Environmental Protection Agency (EPA) as soil fumigants for insecticide, fungicide, nematocide, and herbicide purposes. For soil fumigation, MB is commonly mixed in various proportions with chloropicrin (CP) which, at low concentration, is used as an odorant for MB detection which is odorless and colorless at room temperature.

Over the past three decades in Florida, MB has commonly been used under plastic mulch as a preplant soil fumigant. A preplant application of MB controls a wide variety of pests (e.g., fungi, bacteria, nematodes, soil borne insects and weed seeds) at a much lower cost than the use of many specific individual pesticides.

Method of Application: MB and CP are premixed and sold in reusable, compressed gas cylinders for large scale applications. Application is generally by shank-injection into the soil 6-8 inches (15-20 cm) deep using a positive pressure closed system (pressurized with nitrogen gas). Rates of application commonly vary from 100 to over 400 lbs active ingredient per acre (112-448 kg per hectare) depending on the crop and application site. A polyethylene tarp may be laid down immediately over the soil behind the shanks of the injection equipment. The tarp, although not impervious to MB/CP gases, reduces the dissipation rate of gases into the air which lessens the inhalation hazard to farm workers and increases the overall efficacy of the treatment by subjecting soil pests to greater cumulative levels of MB. Reducing the width of fumigated beds, currently promoted by water conservationists, would result in less MB applied per surface area and less risk of MB exposure to farm workers if current row spacings are maintained.

It is important that appropriate soil conditions be present and land preparations be performed prior to fumigation in order to enhance soil retention of MB and minimize potential worker exposure to this compound. At temperatures above 40F (5C), MB vaporizes rapidly into a gas and diffuses through open soil pore spaces. Since diffusion is faster in air above the soil surface, upward MB mass flow and diffusion is greater than downward movement. Soil moisture extremes (too dry or too moist) prevent MB from achieving the desired pesticidal concentration over time. Tarps should be placed over fumigated areas as soon as possible, because, up to a 40% loss of MB from the soil may occur within 20 minutes when MB is applied to a dry, sandy soil, under conditions of high air and soil temperatures (1).

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Potential Risks to Human Health: MB has come under closer scrutiny in recent years due to an apparent increased incidence of occupationally related cases of overexposure and accidental deaths. Most injuries have occurred during structural and commodity fumigation and not during field agricultural uses (2).

Because MB is an odorless and colorless gas at room temperature, respiratory problems (pulmonary edema) through its inhalation are the most common and serious injuries that it causes. Although gaseous MB is poorly absorbed through the skin, prolonged contact with relatively high concentrations of MB can cause skin blisters and may result in its absorption with subsequent severe lung irritation and damage to the heart, kidneys, and central nervous system. Fatal poisoning occurs at MB concentrations of 2000 ppm for one hour. Non-fatal poisoning has resulted from prolonged exposure to concentrations in the range of 100-500 ppm. In the United States, the threshold limit value (TLV) for acute exposure level of MB in air is 5 ppm. Currently, there is no definitive evidence linking MB exposure to cancer or reproductive abnormalities in humans.

CP should be mixed with MB to minimize the risk of inadvertent exposure. The TLV for CP is 0.1 ppm. Currently, MB products are not recommended by the Florida Cooperative Extension Service unless a chloropicrin content of at least 2% is present in the mixture.

Worker Exposure During Fumigation: Concentrations of MB and CP measured within the breathing zone of drivers and coworkers on injection equipment, and shovelers in the field have been monitored during preplant soil fumigations in California (3). The results from these studies indicate that workers on injection equipment are subject to the highest risk of MB and CP exposure. Lowest exposure levels were always observed with shovelers. In the majority of cases, worker exposure level during application were well within acceptable limits and did not pose a known health hazard to workers. However, in some cases for drivers and coworkers on application equipment, concentrations did exceed the EPA established acute TLV for MB or CP. Concentrations ranged from nondetectable levels to 8.3 ppm for MB and 1.5 ppm for CP. In Florida, a greater risk of worker inhalation exists because of the coarse-textured soils, low organic matter content, low soil moisture and high soil temperatures.

Wind conditions are also of paramount importance due to dilution effects. Wind speeds of at least 1 mph (1.6 km/hr) have recently been proposed in California as a threshold guideline for soil fumigation. In Florida, average wind conditions are difficult to generalize considering the number of large bodies of water which, through differential heating and cooling, influence wind velocity and direction. In general, however, wind speeds are lowest (less than 10 mph, 16km/hr) at daybreak and increase rapidly, after peak heating periods, to an average maximum of 10-15 mph (16-24 km/hr) during late afternoon (4-6 pm).

The majority of agricultural overexposure injuries due to MB during fumigation are skin, eye, and respiratory injuries due to uncoupling or breakage of hoses under pressure, improper application techniques, and changing of MB cylinders. Preventative maintenance programs including preapplication inspections and use of armored MB delivery tubes will prevent

injuries. Eye injuries can be avoided by wearing proper eye protection. New product label restrictions requiring 10 gallons (38 liters) of potable water and a self-contained breathing apparatus on the tractor or in a nearby service vehicle will minimize health hazards in the event of a field accident. Minimizing tarping delays, injection depths of 8-12 inches (20-30 cm) and elevating rear inspection seats or platforms above the soil surface, and away from zones where MB is more likely to accumulate, may reduce exposure. The protection offered by new air conditioned, filtered air, cab systems for tractor drivers of fumigation equipment is not known.

Worker Exposure After Fumigation: Workers who remain near recently fumigated beds subject themselves to potentially harmful and unnecessary respiratory risk and to dermal exposure (Fig. 1). Since MB is a very dense gas and three times heavier than air, it may concentrate to unhealthful levels near the soil surface. It is important that persons take the proper precautions to protect themselves from exposure after application by staying upwind or preferably exiting the field immediately following fumigation. In cases where accidental overexposure to MB was reported, premature removal of tarps from treated areas has been the primary causal factor. In Florida, observance of label requirements prohibiting worker reentry into fumigated fields for 48 hours will reduce exposure hazards.

Worker Exposure Downwind Of Fumigation Site: Atmospheric monitoring studies for concentration of MB and CP in air downwind from field application sites in California have shown that concentrations of MB ranged from below the detectable limit (1.1-3.0 ppb) up to 900 ppb (0.9 ppm) (3). Extensive field monitoring studies generally indicate that levels of downwind worker exposure to MB to be less than 1 ppm, which is 1/20 of the current OSHA work place standard and 1/5 of what the EPA permits. Concentrations of CP ranged from below the detectable limit (1 ppb) up to 81 ppb. In general, agricultural uses of MB and CP should not pose a health hazard under normal conditions to people living or working around fumigated fields.

Risk To Environment: Final degradation products of MB in soil and air include carbon dioxide (CO_2), water (H_2O), and inorganic bromine (-Br). Although inorganic bromine accumulation in soil may be of concern to the EPA, it is not believed to present an environmental hazard since many soils have a normal concentration of bromine in the range of 1-5 ppm. Irrigations following MB fumigation are used where accumulations do occur to leach ion residues from plant root zones. In Florida, bromine accumulation generally does not occur, therefore, leaching irrigations are not necessary. Extensive groundwater testing in Florida has failed to detect residues of MB in groundwaters under areas where MB has been used extensively. MB is not expected to run off fields in surface water because of application methods under plastic tarps.

Summary: Under normal conditions, the available evidence seems to indicate that worker exposure to cautious, responsible field use of MB does not constitute any unreasonable human health or environmental risks. Growers should recognize that MB is a broad spectrum biocide and that carelessness, as it relates to MB use and worker safety, cannot be tolerated. To avoid accidents and to guarantee the continued availability of MB, farm workers must become familiar with safety precautions and technical procedures of soil fumigation. Growers and certified applicators must provide a safe

working environment to include inspection and maintenance of equipment and application procedures. Sufficient time must be allowed for aeration. New MB application manuals, pesticide safety seminars, and pesticide certification requirements for workers and equipment, developed jointly by chemical manufacturers/distributors and government agencies will aid in this regard.

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Fig. 1. Workers should not remain near recently methyl bromide fumigated beds because they subject themselves to potentially harmful risks.

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